# CHAPTER 3

# PAVEMENT MANAGEMENT DATA

## 3.1 PMS DATA REQUIREMENTS

The key component to a quality PMS is quality data collection during the pavement evaluation process. It is important that the data collected during each inspection can be compared with previous pavement inspections. Several methods for data collection are available. The methods selected should reflect the capabilities and goals of the pavement management program.

All pavement management programs should include a visual inspection of some type. A properly executed visual evaluation is one of the most reliable and efficient forms of pavement evaluation available. It is simple, inexpensive, and provides a great deal of valuable information about pavement condition. Visual inspection techniques range from informal drive-overs to formal methods such as the PCI or Long Term Pavement Performance methods. Larger systems, like MPW's, tend to use the more formal systems. These systems, particularly PCI, provide a comprehensive record of pavement distresses at the time of the evaluation and are highly repeatable. Larger systems also tend to use image-based survey methods, which use a vehicle to collect film, video, or digital images of the pavement system. These images are then analyzed for the required distress data. An image-based assessment has the advantages in safety and speed of a drive-over survey without sacrificing the quality of a walking survey. The survey vehicles may also be used to collect additional data, such as roughness or right-of-way images, concurrently with the images.

Additional data are often collected to detect conditions not identifiable by visual inspection. The tests to collect these data are categorized into destructive, semi-destructive, and nondestructive testing.

Destructive testing is the traditional test method to determine physical pavement properties. Tests are conducted in test pits, samples are obtained from core borings, and laboratory tests are conducted on the samples. These tests have the advantage of examining actual in-service materials; however, they also have several disadvantages. Destructive tests are expensive, particularly considering the amount of testing necessary for a network-level survey and the fact that most properties determined by destructive testing change very little between surveys. Destructive testing can also have a significant impact on traffic.

Semi-destructive tests are tests that deploy a penetration device through a small diameter hole. Common semi-destructive tests include the cone penetrometer and dynamic cone penetrometer. Semi-destructive tests typically characterize pavement layer and subgrade strength and moisture level. Although semi-destructive tests are typically faster and cheaper than destructive testing, they still require a small core or drill hole, and still affect traffic flow.

Several nondestructive alternative testing techniques are frequently used to allow examination of a considerably broader expanse of pavement than is practical with physical sampling. Among nondestructive testing techniques are ground penetration radar (GPR), seismic methods, impact and dynamic loading devices, friction measuring equipment, and roughness measuring devices. Each can provide valuable information of conditions and each has certain limitations.  In practice, it is appropriate to select from available nondestructive techniques to fulfill specific investigative requirements.

A PMS also requires financial data to provide accurate results.  The most import data of this type are the treatment costs.  The best sources for cost data are the financial records of previous projects.  If these are not available, bid tabs, quotes, and estimates can be used to determine the cost data.  Financial data should be updated periodically, either by a simple inflation factor, or by recomputing unit costs based on projects completed since the last cost data update.

## 3.2 PAVEMENT DATA SELECTED FOR MPW PMS

The Cartêgraph Pavementview Plus software is capable of storing and analyzing nearly any type of pavement data.  Discussions with MPW personnel indicated that MPW is most interested in the surface condition, rutting, and ride quality of MPW pavements.  A modified ASTM D6433 PCI survey was selected as the network level surface condition assessment procedure.  The PCI method is well defined and is universally accepted and used.  The PCI method also includes provisions to include rutting in the visual assessment.  The International Roughness Index (IRI) was selected as the network level ride quality measurement.  IRI is determined by the absolute vertical travel of a standard wheel and spring system traveling at a standard speed over a pavement.  IRI is typically calculated from non-contact profile measuring devices such as laser or acoustic profilometers.

Deflection data has been used by MPW to determine the structural integrity of the pavements, but this is very costly at the network level.  Roads that carry heavy tractor-trailer vehicles may need periodic evaluation using deflection data.  For most roads in the MPW network, deflection data is not warranted on a network level basis.  Deflection data can be collected more cost effectively on a project level basis when the distress data indicates a possible structural deficiency.

Pavement condition data have a limited life span, i.e., data collected quickly become out of date.  Surface condition data are typically valid for 2 to 3 years.  Profile data are valid for approximately 1 to 2 years.  ARA recommends that each pavement segment in the MPW pavement system be surveyed for surface condition and ride quality every 2 years.  Some high-traffic or high-profile areas may warrant annual inspection.

Data is generally of higher quality if a portion of the network is surveyed every year rather than waiting several years and surveying the entire network.  Using this process keeps the data more up-to-date, and therefore more representative of the actual network conditions.  It also allows MPW to flag problem areas that should be surveyed in sequential years due to rapid deterioration or other issues.

## 3.3 BENEFITS OF DIGITAL IMAGE-BASED DATA COLLECTION

Pavement condition data were collected using image-based survey procedures.  In the past, manual surveys have been used by most agencies to collect pavement distress data.  Manual surveys are labor and time intensive, and data reliability depends on training and rater performance.  A number of studies have shown that manual ratings have high levels of variability with respect to rater repeatability as well as high rater-to-rater variability.

Image-based data collection systems produce permanent pavement surface images, offering the advantage of correlating rater analysis results for accuracy and repeatability.  An additional advantage to using fixed images is the ability to re-calibrate raters who tend to drift from desired interpretations with time. Fixed images also provide a consistent calibration for new raters. The combination of establishing rater performance requirements and performing QC monitoring enables the production of the desired quality of data.

Image-based data collection also provides a record of non-pavement assets, including but not limited to sidewalks, markings, and signs. These images can be made available to other areas of the Public Works Department to aid in planning and maintenance.

## 3.4 DATA COLLECTION PROCESS

### 3.4.1 Network Definition

Before beginning the pavement evaluation survey, MPW pavement network was defined. Roads that MPW is not responsible for maintaining, including state, federal, and private roads, were removed from the network. The network was divided into routes based on street names. Routes were divided into segments based on four criteria:

- **Block-to-block:** Segments change at each intersection,
- **Pavement change:** Segments change at changes in pavement construction history,
- **½-mile:** Segments are no longer than ½-mile in length,
- **Paving groups:** Segments must be entirely within one paving group.

These criteria resulted in a network containing 25,184 segments. Each segment was assigned to one of the five paving groups defined in Chapter 1.

### 3.4.2 Data Collection Vehicle

A survey vehicle equipped with digital cameras was used to collect survey images, which were analyzed for distress at specialized workstations. A laser profilometer mounted on the survey vehicle was used to collect pavement roughness (profile) data. The distress and profile data were then loaded into the pavement management software, and the images linked to pavement management segments. The van-mounted camera and profiler system is manufactured by International Cybernetics Corporation (ICC). This equipment simultaneously collects digital images of the pavement surface and right-of-way, longitudinal profile data (pavement roughness), and transverse profile data (rutting). Additionally, the vehicle is equipped with a differential global positioning system (GPS) receiver and an inertial navigation system capable of measuring the location of the vehicle and the images with sub-meter accuracy. The ARA digital survey vehicle (DSV) is shown in Figure 3.1. The survey system characteristics are summarized in Table 3.1.

Pavement images were collected using the vehicle-based digital imaging system consisting of a Bassler 2,000-pixel digital line-scan camera, a computerized controller, and pavement illumination mounted on a van. The digital line scan camera is mounted on the rear of the vehicle and records continuous images with a width of survey of 14.5 feet (4.4 meters). Both wheel paths are included in the image. The computerized controller synchronizes the digital camera speed to the speed of the vehicle to record distresses as small as 1mm in width at speeds of up to 50 MPH with controlled illumination. The pavement image is divided into 20-foot segments and stored in JPEG format on 40GB removable hard drives. Each drive can hold enough images to cover over 150 lane-miles of survey.


Figure 3.1. Digital survey vehicle.

The pavement illumination system consists of ten 150W metal halide stage lights mounted on a custom framework on the rear of the DSV. The lights are fitted with specialized lenses that focus the light into a narrow band of intense illumination directly under the digital line scan camera. The illumination system ensures consistent lighting during the survey process, and mitigates the effects of cloudy days and shadows.

A Class I, 3-sensor, South Dakota-type Road Profiler, conforming to ASTM E950, was used for road roughness data collection. The profiler was mounted on the DSV used for digital image data collection, as shown in Figure 3.2. It uses three 16-kHz Selcom lasers, accelerometers, and a distance measuring instrument (DMI) to collect pavement profile data.

Figure 3.2. Profiler on digital survey vehicle.

Table 3.1. Survey system characteristics.

| Survey System | Manufacturer | Camera or Sensor Type | No. of Sensors | Resolution or Accuracy | Survey Speed, Max |
|---|---|---|---|---|---|
| Digital Pavement Imaging System | International Cybernetics Corporation | Bassler Line-Scan Monochrome | 1 | 2,000 pixels per scan line | 50 MPH @ 20-ft image Intervals |
| Road Profiler | ICC | Selcom, 16 kHz, Laser | 3 | 0.002 inches | 60 + MPH |
| GPS Receiver | Trimble | AG 132 | 1 | Sub-meter | 60 + MPH |
| Differential GPS | Applanix | DGPS | 2 | Sub-meter | 60 + MPH |
| POS LV – X, Y Position | Applanix | N/A | 1 | 0.20 m | 15-sec signal outage |
| POS LV – Z Vert. Pos. | Applanix | N/A | 1 | 0.20 m | 15-sec signal outage |
| Roll & Pitch | Applanix | N/A | 1 | 0.07 degrees | 15-sec signal outage |
| True Heading | Applanix | N/A | 1 | 0.07 degrees | 15-sec signal outage |
| Windshield & Shoulder Images | ICC | Color, Digital Video Camera | 3 | 1300 by 1024 pixels, each | 60 + MPH @ 25-ft intervals |
| Distance Measuring Instrument | ICC | N/A | 1 | 1ft per mile | 60 + MPH |

### 3.4.3 Pavement Distress Data

Distress data were obtained by analyzing digital images of the pavement segments for distresses. The DSV was used to collect images of all MPW street segments. Figure 3.3 is a typical pavement image. A test section of roadway located in Nashville was used for verification and quality control of pavement distress analysis. Detailed distress data were collected for this section prior to starting data collection. Thereafter, the site was surveyed every week or every 500 miles.

Periodically, the digital images from the DSV were shipped to the data processing center in Harrisburg, PA. The images were merged into the master project database for data reduction. The data were reviewed to ensure that the images were complete and of good quality, and that the segment limits were marked properly. Any necessary revisions were made and the images were made available for pavement distress data reduction. If necessary, the pavement images were re-collected.

Pavement distress data reduction was performed at specialized workstations. Each workstation has three monitors. One monitor displays a scale pavement image; the second displays two right-of-way (ROW) images, while the third displays the program controls and data entry screen. The images for each segment were viewed and the data entered into the project database. Trained pavement distress raters performed the distress data reduction using ASTM Standard D6433-99 (PCI for Roads and Parking Lots). Fifty percent of the pavement images were analyzed. The data collected were summarized in a format that could be loaded into the Cartêgraph PavementView Plus pavement management software.

### 3.4.4 Right-Of-Way Images

ROW images were collected at 20-foot intervals using 1300 pixel x 1024 pixel digital color cameras. The primary ROW camera was pointed straight ahead of the survey vehicle. The secondary ROW camera was pointed 17 degrees to the right for a view of assets not located on or above the pavement. ROW images are linked to pavement images and other data collected by the DSV using GPS or distance-measuring instrument data. Sample ROW images are shown in Figures 3.4 and 3.5.

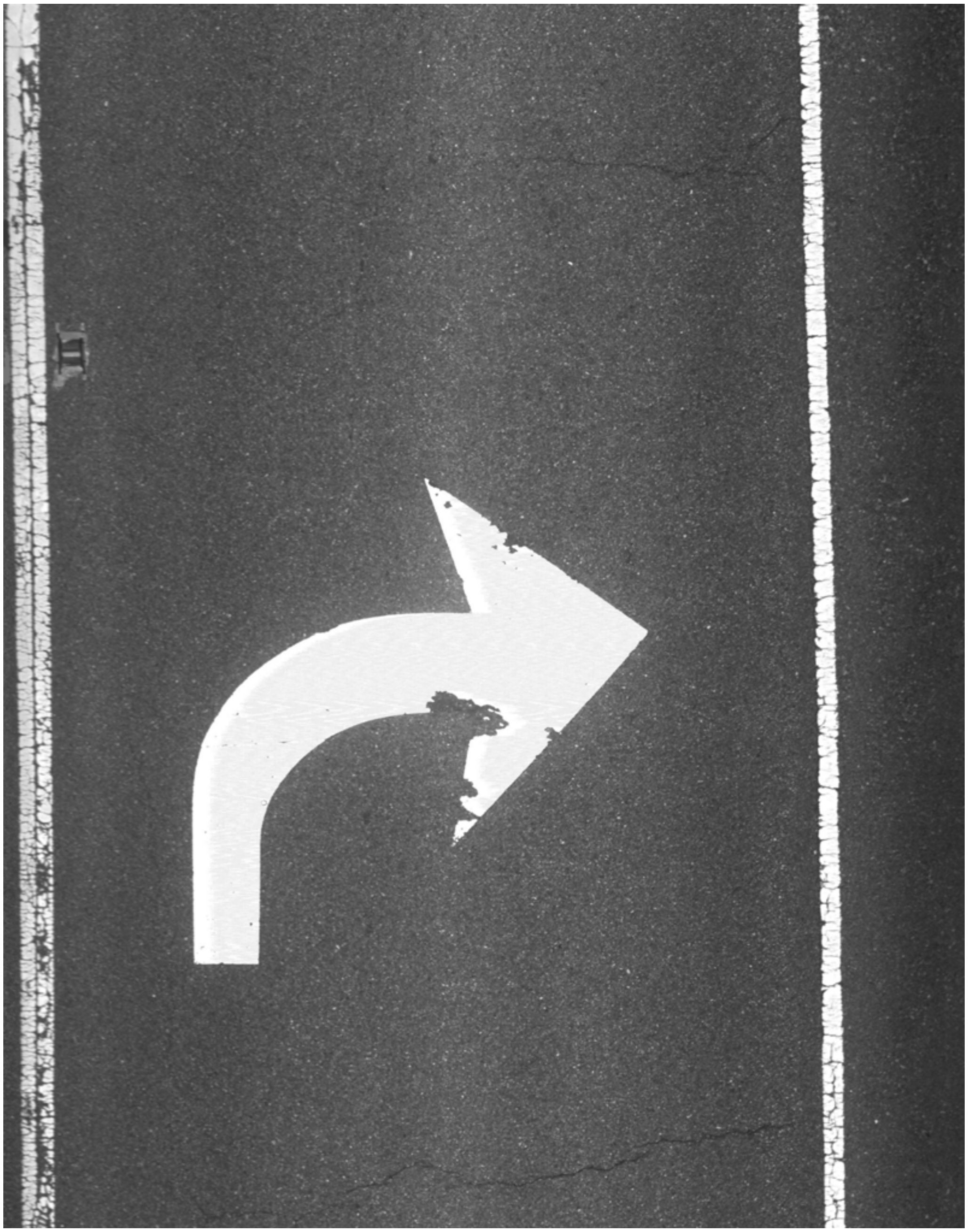

Figure 3.3. Sample image from downward camera.


Figure 3.4. Primary ROW image.


Figure 3.5. Secondary ROW image.

### 3.4.5 Road Roughness Data

The International Roughness Index was calculated from the profile data. Rut depth was also calculated by comparing profile data from each wheel path to the center sensor. Software simulates placing a straightedge across the wheel paths and measuring the rutting from this reference.

Profile measurements were collected at intervals of approximately 3 inches. The laser sensors have a height resolution of 0.002 inch. The system uses the continuous 16-khz output of the lasers to determine the height points, a process that eliminates narrow cracks and openings from roughness calculations.

Industry standard reporting software, developed by ICC and UMTRI, were used to convert the sensor and accelerometer readings into longitudinal profiles and calculate IRI in accordance with ASTM E1926-98.

ARA data collection equipment is periodically calibrated at profiler validation sites in Harrisburg, PA. These sites are chosen and maintained by the Pennsylvania Department of Transportation (PennDOT). The sites have been selected by PennDOT to cover the range of roughness applicable to most highway systems. The profiler equipment traverses each site three times. The IRI for each run at each site is determined by using the software developed by ICC. These IRI values were averaged. The average IRI for each site was compared with the reference IRI for that site to verify accuracy. In addition, the IRI value for the individual runs of each site were compared with the average IRI of that site to verify repeatability. The internal quality assurance (QA) accuracy requirement is +/- 5%.

A test site for roughness verification was also established in Nashville for quality control. The site was surveyed every week or every 500 miles. The results of each survey were compared with the initial reference values to verify accuracy and repeatability.

## 3.5 OVERALL CONDITION INDEX

PMS software stores, sorts, and analyzes large amounts of many different types of data. This data must be represented in a manner to allow human pavement managers to compare the relative quality of pavement sections to make a decision about M&R and funding priorities. The OCI is a single number representing the condition of a pavement section based on all the data available for that section. MPW PMS is set up such that the OCI ranges from 0 to 100, with a 0 OCI indicating failed pavement and a 100 OCI indicating perfect pavement.

Cartêgraph Pavementview Plus allows the user to combine several condition indices (cracking, rutting, PCI, roughness, etc.) to calculate the OCI. The OCI defined by MPW is a combination of PCI and IRI. PCI reflects surface condition, rutting, and structural cracking, while IRI reflects ride quality. OCI is determined according to:

$$OCI=(0.80PCI)+(0.20IRI_n)$$

where:

PCI is the segment PCI

$IRI_n$ is the normalized IRI

This equation applies weighting factors to the PCI (80%) and IRI (20%) so that the OCI properly represents the impact of both indices on pavement performance and serviceability. The

IRI value must be normalized for use in the OCI calculations, because IRI differs from most condition indices in that it increases as condition worsens rather than decreases.

### 3.5.1 Pavement Condition Index

The PCI method is a distress based condition index, i.e., specific distresses in the pavement are identified and tallied, and the type, severity, and extent of each distress is used to calculate a single number representing the pavement condition. This number is a composite value representing both structural integrity and serviceability, with higher numbers reflecting better pavement. A distress is any pavement condition that causes a loss of serviceability. Typical distresses include cracks, ruts, and bumps. ASTM D6433 defines 38 distinct distresses; 19 for AC pavements and 19 for PCC pavements as listed in Table 3.2. Most distresses have three severity levels defined by the standard - high, medium, and low.

A modified ASTM D6433 standard was used to determine the PCI for MPW roads. ASTM D6433 was developed using manual survey methods. This survey used automated methods, which detect certain distresses, particularly rutting, better than manual methods. To account for this, the deduct values, which reflect the loss of serviceability caused by a distress, were adjusted to account for the increased volumes of rutting detected. The adjustment factors shown in Table 3.3 were applied to the rutting deduct value tables to reduce the impact of rutting on the PCI.

The process of determining the PCI of a pavement is highly repeatable. Distresses are objective and quantifiable; calculations for determining the PCI of a pavement are standardized. There is no room for differing “expert opinions” of the impact of a given distress on serviceability. A given set of distresses will always result in the same PCI. It is possible to achieve a 95% confidence interval of less than five PCI points even when less than 15% of the pavement has been examined.

The PCI value of a pavement is determined by visually inspecting a segment of pavement and recording distress types and severities present. Each distress type, severity, and amount has an associated deduct value, reflecting the decrease in serviceability caused by that distress. The deduct values are totaled and adjusted for the amounts and types of distresses. The resulting number is the PCI for that pavement segment.

Each pavement segment must either be surveyed in its entirety, or broken into sample units for statistical sampling. A sample unit is a portion of a segment that is a convenient size for counting distresses. Sample units, in accordance with the ASTM standard, should be between 1500 $ft^2$ and 3500 $ft^2$ in size. If an image-based survey method is used, images frames should be combined to form appropriate size sample units. This survey analyzed 50% of the image frames for distresses.

Statistical sampling allows calculation of the PCI of a pavement without measuring every single distress located on that pavement. Statistical sampling is often used for network level surveys. A network level survey is a "snapshot" of the condition of the entire network, used to determine pavement rehabilitation needs and priorities. Network level surveys differ in scope and detail from project level surveys, which are used to determine project extents and rehabilitation activities. Project level surveys are typically performed on segments identified as candidates for rehabilitation by a network level survey.

Table 3.2. Distresses in AC and PCC pavements as defined by ASTM D6433.

| AC Distresses | PCC Distresses |
|---|---|
| Alligator cracking | Blow-up |
| Bleeding | Corner break |
| Block cracking | Divided slab |
| Bumps and sags | Durability cracking |
| Corrugation | Faulting |
| Depressions | Joint seal damage |
| Edge cracking | Lane/shoulder drop-off |
| Joint reflection cracking | Linear cracking |
| Lane/shoulder drop-off | Large patches |
| Longitudinal and transverse (L&T) cracking | Small patches |
| Patching and utility cuts | Polished aggregate |
| Polished aggregate | Popouts |
| Potholes | Pumping |
| Railroad crossing | Punchout |
| Rutting | Railroad crossing |
| Shoving | Scaling |
| Slippage cracking | Shrinkage cracking |
| Swelling | Corner spalling |
| Weathering/raveling | Joint spalling |

Table 3.3. Rutting deduct value adjustment factors.

| Rutting Severity | Adjustment Factor |
|---|---|
| Low | .100 |
| Moderate | .143 |
| High | .422 |

### 3.5.2 International Roughness Index

IRI is a measurement of ride quality, expressed as the amount of vertical travel a given road will create in a standard suspension assembly. Results are typically expressed in terms of inches per mile. Higher values indicate more suspension travel and, therefore, a lower ride quality. New pavement typically has an IRI of approximately 75 in/mile to 100 in/mile. IRI values above 300 are normally considered rough. The most accurate method to determine IRI is to calculate it using profile information collected from the rutting sensors on the survey vehicle.

IRI data were normalized to a 100-point scale so that it could be included in the OCI. To normalize the data, the data were plotted on a histogram to determine the range and distribution of IRI within the network. Normalized IRI values were then assigned to IRI ranges based on the scale in Table 3.4.

Table 3.4. Normalized IRI values.

| IRI | $IRI_n$ |
|---|---|
| 0 | 100 |
| 100 | 90 |
| 150 | 80 |
| 200 | 70 |
| 250 | 60 |
| 300 | 50 |
| 350 | 40 |
| 400 | 30 |
| 500 | 20 |
| 600 | 10 |
| 800 | 0 |

## 3.6 FINANCIAL DATA

### 3.6.1 Budgets

Budgets are defined by three factors: the year of the plan, the type of budget, and the amount available for that type of budget and year. Some agencies only have one type of budget for their networks; in MPW's case there are two. The first budget is for the roads in the network where repairs are fully funded by MPW. The second budget is for state-aid roads: roads where the State of Tennessee pays for part of the pavement repair. Budget data are typically determined from previous years funding levels and adjusted for any anticipated changes. A budget must be defined for each year the software is developing a plan.

### 3.6.2 Costs

The Cartêgraph Pavementview Plus software can accommodate an array of pavement preservation, maintenance, and rehabilitation activities. Unit costs are associated with each activity, and the unit costs are multiplied by the area of the street selected for repair to calculate the total cost of M&R. In addition to unit cost, the type of budget that this activity draws its money from must be specified. If multiple budget types can be used, copies of the same activity must be specified. Table 3.5 lists the unit costs used for the M&R treatments selected by MPW. These costs were developed by reviewing bid tabs and work order histories for projects completed by MPW in the past 2 years. Unit material costs may fluctuate due to market forces in the petroleum and construction industries, as reflected by the Asphalt Index.

Table 3.5. Unit costs and selection criteria for maintenance activities.

| Maintenance Activity | Unit Cost |
|---|---|
| 1.5-in AC Overlay - D Mix | $3.10/sy |
| 1.5-in AC Overlay - E Mix | $3.05/sy |
| 1.5-in AC Overlay - Poly | $3.50/sy |
| 1.5-in AC Overlay - RCW | $2.90/sy |
| 1.5-in Mill & Overlay – D Mix | $4.10/sy |
| 1.5-in Mill & Overlay – E Mix | $4.05/sy |
| 1.5-in Mill & Overlay – Poly | $4.50/sy |
| 1.5-in Mill & Overlay – RCW | $3.90/sy |
| AC - AC Overlay < 2" | $3.85/sy |
| AC - Crack Seal with routing | $2.00/lf |
| AC - Patching - Full Depth | $19.00/sy |
| AC - Patching - Partial Depth | $10.50/sy |
| AC - Reconstruct - Full | $20.50/sy |
| AC - Shoulder - Fill & Regrade | $2.50/sy |
| AC – Single Surface Treatment | $1.00/sy |
| AC – Double Surface Treatment | $2.00/sy |

## 3.7 GASB 34 REQUIREMENTS

GASB 34 stands for Governmental Accounting Standards Board Statement 34. GASB is the organization that provides guidelines for financial reporting. GASB 34 is a policy statement issued in 1999 recommending significant changes in the structure of financial reporting methods by government entities. One area greatly affected by GASB 34 is valuation of long-term assets, such as bridges, roads, and other infrastructure items.

Prior to 1999, all governmental assets were valued at their purchase (construction) price and depreciated a set amount each year. Annual depreciation on all assets was listed as an expense in financial reports. Repairs to the asset were considered expenses, but any preservation or rehabilitation treatments, e.g., rejuvenators or microsurfacing, were considered capital expenditures that must also be depreciated. Under this system, a government had little financial incentive to preserve infrastructure items, as financial reports would show large capital expenditures with little or no improvement in serviceability observed by the average citizen.

GASB 34 introduced the concept of "perpetual assets" into accounting, i.e., assets that depreciate with serviceability, not time. The perpetual asset concept recognizes the reality that a 20-year-old road in satisfactory condition is just as valuable as a 2-year-old road in satisfactory condition. The road should not be depreciated and the depreciation listed as an expense simply because it is old. Instead, any preservation or rehabilitation maintenance to keep the road in satisfactory condition should be listed as an expense. This is known as the modified approach to reporting.

To be allowed to use the modified approach, an agency must have in place a system to evaluate and track asset condition, and assets must be maintained at a target serviceability level. The PMS system implemented by MPW exceeds the GASB requirements for tracking pavement condition, and the MPW pavement management program specifies inspecting 50% of the pavement network annually. MPW has selected a target serviceability level for the network of 70% of all pavements having an OCI greater than 70.

## 3.8 CURRENT NETWORK CONDITION

MPW street network consists of 25,184 segments defined out of 2604.0 centerline miles and 349,910,664 ft² of roadway. The area-weighted average OCI of all streets in the network is 84. All paving groups exceed the GASB target serviceability level, as shown in Table 3.6 and Figure 3.6. Notice that the percentage of lane miles with OCI≥70 is greater than the percentage of segments with OCI≥70. This indicates that the segments below OCI 70 are relatively short segments. The most common distress is low severity rutting, followed by linear cracking, patching, and medium severity rutting.

Figure 3.7 is a map of MPW highlighting the current conditions of MPW roads. Green indicates the roadway is in satisfactory condition (OCI of 70 or above) and red indicates unsatisfactory condition (OCI below 70). Non-MPW roads are shown in gray.

Table 3.6. Network condition summary.

| **Paving Group** | **% of Network with OCI ≥ 70*** | | |
|---|---|---|---|
| | **By Segment** | **By Area** | **By Lane Mile** |
| Group 1 | 95.1% | 95.3% | 95.9% |
| Group 2 | 93.0% | 94.9% | 95.2% |
| Group 3 | 62.1% | 83.1% | 87.2% |
| Group 4 | 80.4% | 86.0% | 87.6% |
| Group 5 | 67.4% | 78.0% | 80.7% |
| All Groups | 88.6% | 89.5% | 90.3% |

*Does not include raveling.

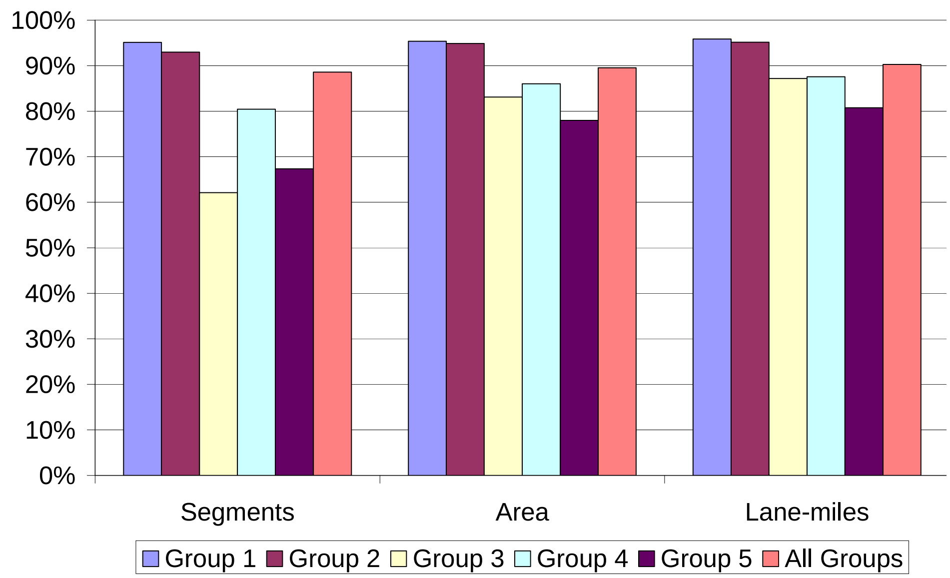


Figure 3.6. Percentage of network with OCI≥70.

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Figure 3.7. Color-coded map of Davison County showing OCI ranges of roadways.

## 3.9 DETERIORATION MODELS

Deterioration models are used to estimate pavement condition in future years. This allows the software to determine the likely M&R needs for pavement segments several years into the future. Deterioration models typically take the form of a family curve. A family curve is developed by regression analysis of age-vs.-condition data for a group of similar pavements. Deterioration models for individual condition categories can be specified in the table shown. The OCI deterioration model is then calculated by the program using the weights of individual condition categories. The family curve can then be used to estimate the future condition of pavements similar to the ones used to build the family curve, as shown in Figure 3.8.

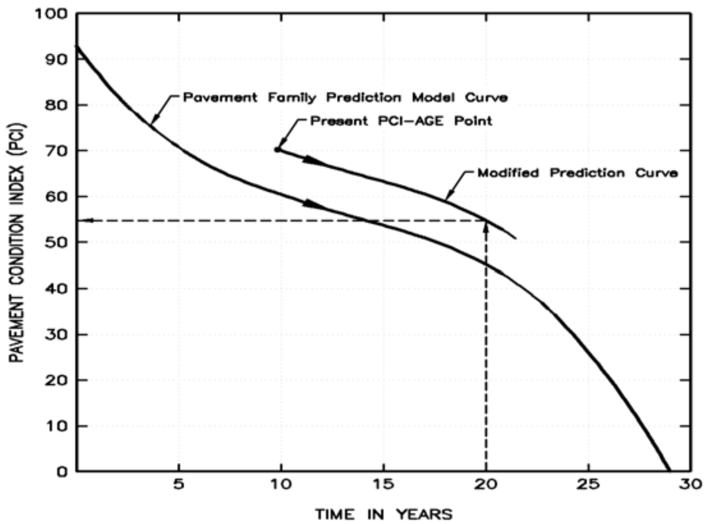


Figure 3.8. Predicting pavement condition.

Four deterioration curves were developed for MPW based on functional class: major arterial, minor arterial, collector, and local. Functional class data were provided by the Metropolitan Planning Organization (MPO). MPO data were used to increase the level of integration among the data in MPW GIS. Curves were developed using non-linear regression techniques on approximately 11,000 age-condition data points. Figure 3.9 shows the four MPW pavement deterioration curves.

All pavements tend to deteriorate at approximately the same rate until about 8 years of age, after which point arterial pavements tend to deteriorate faster than local and collector pavements. The prediction curves indicate that major arterial streets deteriorate below an OCI of 70 (unacceptable condition) in slightly more than 10 years. Minor arterial streets fall to an OCI of 70 in approximately 12 years. Local and collector streets remain above an OCI of 70 for more than 15 years.

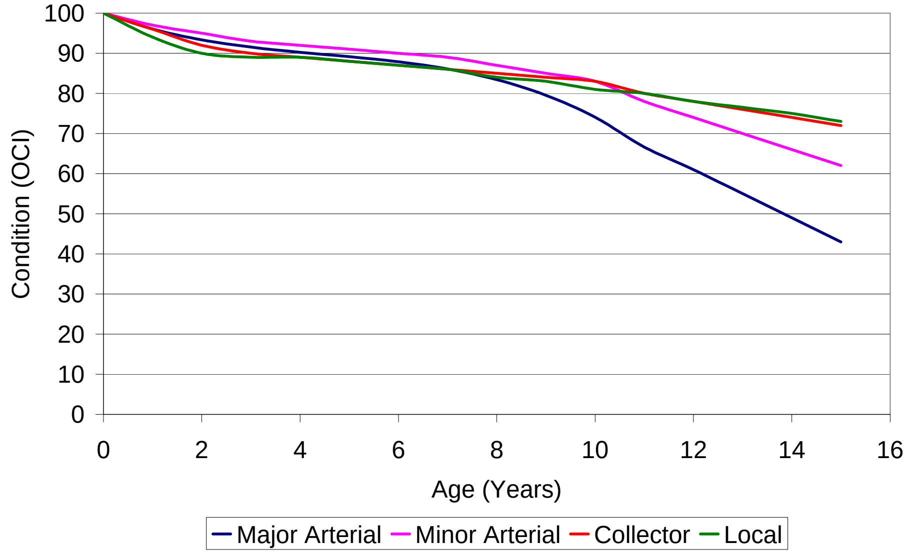


Figure 3.9. MPW deterioration curves.